United States
Department of
Agriculture

Office of
Agricultural
Biotechnology

Minutes

Agricultural Biotechnology Research Advisory Committee

November 17, 1994
Monterey, California

Document No. 94-01

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL BIOTECHNOLOGY RESEARCH ADVISORY COMMITTEE
Minutes of Meeting
November 17, 1994

Time, Place, and Participants

The U.S. Department of Agriculture (USDA) Agricultural Biotechnology Research Advisory Committee (ABRAC) met November 17, 1994, in the Portola Room of the Doubletree Hotel at Fisherman's Wharf in Monterey, California. The meeting had been announced in the *Federal Register* and it was open to the public.

Members present included:

Walter A. Hill, Chair, Tuskegee University, Tuskegee, AL;
James Lauderdale, The Upjohn Company, Kalamazoo, MI;
Anne Kapuscinski, University of Minnesota, St. Paul, MN;
Roy Fuchs, Monsanto Agricultural Company, St. Louis, MO;
H. Alan Wood, Boyce Thompson Institute for Plant Research, Ithaca, NY;
Fernando Osorio, University of Nebraska, Lincoln, NE;
Ronald R. Sederoff, North Carolina State University, Raleigh, NC;
Pamela G. Marrone, Novo Nordisk Entotech, Inc., Davis, CA;
Rudy Wodzinski, University of Central Florida, Orlando, FL;
Deborah K. Letourneau, University of California/Santa Cruz, Santa Cruz, CA;
Walter Reid, World Resources Institute, Washington, DC;
Stanley Pierce, Rivkin, Radler, & Kramer, Boca Raton, FL;
Paul Thompson, Yale University, New Haven, CT;
Alvin L. Young, Executive Secretary, ABRAC, and Director, USDA Office of Agricultural Biotechnology, Washington, DC.

USDA Office of Agricultural Biotechnology (OAB) staff members present included Daniel Jones, Maryln Cordle, and Marti Asner. Others present are listed in Appendix A.

Call to Order and Introductory Remarks

Dr. Hill called the meeting to order at 9:07 a.m. and introduced Dr. Young, Executive Secretary of the ABRAC. Dr. Young briefly reviewed the functions and history of the ABRAC. He indicated that organizational changes at USDA have changed the reporting structure of the ABRAC; the Committee now reports to the Secretary of Agriculture through the Under Secretary for Research, Education, and Economics.

Dr. Hill proposed modifying the agenda to defer the orientation for the new ABRAC members to the following day. This would allow the discussion of the aquatic research standards to be completed on the first day of the meeting. Dr. Pierce so moved and Dr. Osorio seconded. Dr. Lauderdale suggested that the public be notified of the change through a notice at the hotel; Ms. Asner agreed to see to it. The motion carried unanimously.

Dr. Hill asked the ABRAC members to introduce themselves. Dr. Young presented each member with a certificate of appointment signed by the Secretary of Agriculture.

Dr. Young announced that Dr. Susan Harlander had resigned from the ABRAC for personal reasons and may need to be replaced. He also indicated that Dr. James Tiedje of Michigan State University, a new member, was unable to attend the meeting on the first day.

Background on Performance Standards for Aquatic Research

Dr. Hill introduced Ms. Cordle who reviewed the background of the performance standards for research with genetically modified fish and shellfish. She began with the request for USDA approval from Auburn University in the late 1980's to conduct the first transgenic fish study in outdoor research ponds. The proposed study involved transgenic carp containing a growth hormone gene from rainbow trout.

USDA bore responsibility for the Auburn transgenic carp research because of its partial funding of the research under the Hatch Act. USDA, with the assistance of several fish experts, therefore drafted an environmental assessment (EA) under the National Environmental Policy Act (NEPA) and provided an opportunity for public comment. The scientific issues of the Auburn proposal were discussed at several ABRAC meetings and, in November, 1990, USDA published its concurrence that the research should go forward based on a revised EA and a "finding of no significant impact."

A year later, Auburn proposed a similar study of transgenic catfish. The ABRAC and a group of fish experts agreed that the biosafety protocol for the proposed transgenic catfish study was adequate. By that time, USDA's Cooperative State Research Service (CSRS) had finalized its implementing regulations for NEPA. CSRS concluded that the research could be conducted safely and that formal preparation of an EA was not necessary because the experimental conditions fell under an exemption finalized in the CSRS NEPA regulations.

The Auburn proposals illustrated the scientific complexities and environmental concerns associated with research on genetically modified aquatic organisms. The ABRAC, in order to facilitate future research in this area and to address relevant environmental concerns, formed a Working Group on Aquatic Biotechnology and Environmental Safety (hereinafter referred to as the Working Group).

The purpose of the Working Group was to develop voluntary performance standards for the ecological safety assessment and the design of adequate biosafety protocols for research with genetically modified fish and shellfish. The term "performance standards" is intended to focus on goals to be achieved and

criteria for achieving them. Unlike a design standard, performance standards are neither rigid nor prescriptive. Instead, they allow use of the most appropriate ways to meet the criteria and goals in specific cases.

The Working Group was chaired by Dr. Anne Kapuscinski, University of Minnesota, and included several ABRAC as well as non-ABRAC experts. The Working Group, with funding support from USDA, the Sea Grant Program, and the State of Minnesota, convened a 3-day workshop in August 1993 in Minneapolis. About 100 participants from academia, business, government, interest groups, and 7 different countries reviewed and critiqued draft performance standards prepared for the workshop.

Dr. Kapuscinski, at the December 1993 ABRAC meeting, reviewed the major recommendations from the workshop and summarized the unresolved issues. Among the ABRAC's suggestions was a conceptual approach for linking the sections on risk identification and risk management. Subsequently, Dr. Kapuscinski and Ms. Cordle spoke at several conferences in the United States and overseas concerning environmental issues associated with aquatic biotechnology research.

The Working Group met again in September 1994 to consider revised flowcharts and restructured supporting text of the performance standards. The Working Group recommended that the performance standards be developed into a computerized expert system for ease of distribution and use. Ms. Cordle reported that she had discussed the development of such an expert system with Dr. David MacKenzie, Director, USDA National Biological Impact Assessment Program (NBUAP) which had developed similar expert systems for other groups of genetically modified organisms.

Dr. Kapusciniski, based on suggestions from the September 1994 Working Group meeting, had revised the flowcharts and text of the performance standards prior to this meeting. Ms. Cordle said the revised standards would be distributed to the 1993 workshop participants and others on a mailing list. After a 45-day comment period, the Working Group will consider any comments as well as recommendations from this ABRAC meeting as it prepares a final draft. For that reason, Ms. Cordle indicated that the ABRAC was not being asked to take a final action on the performance standards at this meeting.

Presentation of Draft Performance Standards

Dr. Kapuscinski presented the current version of the proposed performance standards (summarized as flowcharts in Appendix B). She pointed out that aquatic organisms have three features that make them different from other groups of organisms: 1) many aquatic species originate in the same geographic area where they are

cultivated for commercial purposes, i.e., there are wild populations of the same species and close relatives in the adjoining ecosystem; 2) many of the cultivated stocks are not domesticated to the extent that they would fail to survive if they escaped; and 3) many wild fishery populations themselves are considered to be economically important.

Dr. Kapuscinski indicated that different groups of flowcharts in the performance standards deal with applicability of the standards, survival/reproduction assessment, ecosystem effects assessment, risk management for specific risks, and risk management for insufficient information. The applicability section poses certain general questions of reproductive mode and ecological distribution so as to facilitate early exit from the standards if appropriate. In fact, opportunities to exit the standards when appropriate appear throughout the standards. The performance standards are designed to retain genetically modified organisms (GMO's) that express novel or unfamiliar traits so that the risk of such a GMO to other species and to the ecosystem can be assessed.

The survival and reproduction assessment explores the potential biotic impacts of GMO's for three different kinds of genetic modification: deliberate gene changes; deliberate chromosomal manipulations; or interspecific hybridization. Possible outcomes from the survival and reproduction assessment are the following.

- The reason for safety is identified; the researcher can exit the standards.

- Specific risks are identified; the researcher proceeds to a section on risk management for specific risks.

- Insufficient information is available; the researcher proceeds to a section on risk management for insufficient information.

- More information on ecosystem effects is needed and it can be obtained by proceeding to an ecosystem effects assessment.

The ecosystem effects assessment asks if a GMO with potential for interbreeding contains changes in phenotypic traits identified in Table 1 (in Appendix B). If the answer is "no," the research can exit the standards. If the answer is "yes," the researcher needs to address information about the reproductive potential, gene flow, and fitness in a GMO population, as well as the structure and processes of the accessible ecosystem. If evaluation is not possible because of insufficient information, then the researcher proceeds to risk management.

The risk management section describes a range of design and operational measures to help manage both specific risks and situations in which risk cannot be ruled out because of insufficient information. These measures include project siting,

security, alarms, operational procedures, design of barriers (mechanical, physical/chemical, biological, and scalar), peer review, and inspections. The individual researcher is responsible for developing the appropriate combination of risk management measures to achieve the intended level of confinement.

Dr. Kapusciniski indicated that Dr. Eric Hallerman, Virginia Polytechnic University, had designed a worksheet to help researchers document both the decision path through the performance standards and any risk management measures undertaken. Several Working Group members had, for illustrative purposes, completed the worksheets for three specific examples: 1) field testing of channel catfish expressing an introduced growth hormone gene in Alabama; 2) investigation of the resistance of triploid Pacific oysters to the disease MSX and dermo in Chesapeake Bay; and 3) investigation of growth performance of hybrid striped bass/white bass in Lake Rend, a southern Illinois reservoir.

Committee Discussion of the Performance Standards

Dr. Wodzinski asked if enough is known about any fish system to avoid extensive use of confinement measures for genetically modified fish. Dr. Kapuscinski replied that there are currently not many situations in which enough is known about both the GMO and the ecosystem to avoid confinement. However, she emphasized that the performance standards should help to move the research forward by providing incentives for the research community to gather new kinds of data needed for ecosystem effects assessment.

Dr. Osorio asked how the standards deal with floods. Dr. Kapuscinski explained that the risk management section deals with project siting and recommends that freshwater sites be placed on or above a 100-year floodplain. She said the standards recognize that marine and estuarine sites cannot be placed above a 100-year floodplain. Instead, she said, the standards recommend that experiments in tidal areas be kept small enough so that the animals can be moved to an alternative site if necessary or destroyed witnin a specified time if waves or wind threaten the site.

Dr. Fuchs asked how researchers have documented components of fitness of aquatic GMO's. Dr. Kapuscinski replied that Rex Dunham of Auburn University is doing risk assessment research on aspects of fitness of transgenic fish. Ms. Cordle added that Purdue researchers are also examining aquatic GMO fitness and its implications for risk assessment.

Dr. Thompson suggested that some risk management procedures could be more dangerous than escape of the GMO's, particularly during a hurricane. Dr. Kapuscinski replied that the standards strongly recommend development of an emergency response plan that addresses

steps to be taken in the event of hurricanes or other natural disasters that are most likely to threaten a given site. As with marine sites, she said, the scale of the experiment should be kept small enough to permit movement to a safe site or destruction of animals before disaster conditions become too dangerous to complete the action.

Dr. Wodzinski observed that tornadoes are more frequent than hurricanes and strike with less advance warning. Dr. Osorio suggested that aquatic GMO's would not be likely to survive a direct hit by a tornado. Dr. Kapuscinski added that aquatic research is not risk-free, and that is why risk assessment and risk management activities are conducted.

Dr. Kapuscinski summarized the worksheet examples of 1) the investigation of the resistance of triploid Pacific oysters to diseases of oysters in the Chesapeake Bay region and 2) the investigation of growth performance of hybrid striped bass/white bass in a southern Illinois reservoir.

Dr. Reid said he was impressed with the draft, but he asked if Table 1 was inclusive enough especially with regard to introgression and increases in fitness. Dr. Kapuscinski replied that the present version of Table 1 was preceded by an extensive debate concerning fitness and other issues. An important consideration, she said, was that the performance standards should pose easier questions early in the decision process and defer more complex questions to later. Questions of increased fitness, for example, could be addressed in Chart V concerning effects on ecosystem structure and processes. Dr. Kapuscinski expressed the view that Table 1 would hold up in a peer review.

Dr. Wood expressed concern about unanticipated physiological effects of marker genes. Dr. Kapuscinski replied that marker genes could be subjected to the same kinds of testing for physiological effects as other genes. Dr. Letourneau advocated more extensive data collection on unanticipated physiological effects. Dr. Sederoff argued that many gene changes that can be used as markers are essentially neutral and should not require extensive risk data collection. Dr. Letourneau replied that some past assumptions about the effects of marker genes have been shown to be incorrect. Dr. Sederoff distinguished between neutral marker genes and the effects of alternate forms of the same gene.

Dr. Fuchs said the performance standards decision process includes an appropriate level of detail and is actually simpler than it looks at first sight. He added that conversion of the standards to an expert system should be feasible and is crucial to making the standards more useful to researchers.

Dr. Osorio asked who the intended users were. Dr. Kapuscinski replied that the expected clientele is mostly academic with some

government and industry participation.

Dr. Lauderdale suggested that the purpose of the standards should be stated more clearly at the beginning of the document. He raised the question of the consequences of a wrong turn in traversing the decision tree and expressed hope that the consequences would be minimal. Ms. Cordle replied that the planned user testing would address that issue as well as others. Dr. Lauderdale recommended that the user testing population include non-scientists as well as scientists.

Dr. Thompson asked whether excessive reliance on automated alarm systems at an experimental site could be counterproductive and cause safety problems. Dr. Kapuscinski recommended general reliance on human presence for detection of safety problems with use of automated alarms only as a backup. Dr. Colt added that a well-trained human is superior to an alarm for detecting safety problems and that the standards should strive for passive safety measures that give people adequate time to correct problems. He said careful site selection is the key to reliable confinement. Dr. Wodzinski recommended a balance between human and automated alarm systems to maximize the advantages of each.

Dr. Wood recommended that all employees at an aquatic research facility be required to read the emergency response plan and sign a statement that they understand it. Dr. Kapuscinski replied that a statement to that effect could be added.

Dr. Thompson asked how one could be confident that the experiment would be terminated in the event of a natural disaster. Ms. Cordle replied that in the Auburn studies, a responsible official other than the principal investigator had that responsibility. Dr. Young indicated that the director of the experiment station would have that responsibility for research funded in whole or in part by USDA.

Dr. Marrone asked how many academic and industrial groups are expected to use the performance standards. Dr. Kapuscinski estimated that about 50 academic research teams and about a dozen industrial groups are expected to use the standards.

Dr. Wood asked what is meant by a "negligible" level of escape. Ms. Cordle replied that "negligible" is intended to mean "too inconsequential to pay attention to." Dr. Kapuscinski added that a zero-risk level from escaped GMO's cannot be guaranteed and that researchers may need guidance concerning the baseline to which "negligible" refers. Dr. Sederoff offered the interpretation that "negligible" could imply no biological or liability consequence from escaped GMO's. Dr. Kapuscinski said she would add a sentence to the standards clarifying that the word "negligible" refers to biological consequences.

Dr. Wood said that some experiments should not allow any escapees at all. Dr. Kapuscinski agreed, saying that in the case of self-fertilizing hermaphrodites or parthenogens, for example, not a single organism can be allowed to escape.

Dr. Sederoff inquired about the incremental risk of two non-hermaphroditic individuals escaping. Dr. Kapuscinski replied that the escape alone would not necessarily create a risk. Such organisms, she said, would need to find each other and be matched properly in order to pose a risk. Dr. Letourneau suggested that comparative probabilities may need to be considered. A pregnant female, for example, would be less likely to escape than a hermaphrodite.

Dr. Thompson suggested that the long decision trees and documentation procedures for risk management would be too onerous for researchers. Dr. Kapuscinski replied that much of the process can be computerized and that an expert system could provide a record of the researcher's pathway through the decision tree. This record and edited worksheets would provide useful documentation for possible peer reviews of the proposed experiment. Dr. Kapuscinski suggested that most researchers would not find the risk management worksheet too onerous as long as it clarifies the risk or safety aspects of their proposal.

Dr. Sederoff inquired about the timeframe for completion of the performance standards. Dr. Kapuscinski replied that she hoped to revise the standards by Christmas for distribution to the participants in the Minneapolis workshop and others. Dr. Sederoff advocated an early start on the expert system since it could be a critical factor in obtaining USDA approval of the standards.

Dr. Young pointed out that obtaining Departmental approval of the standards would be a challenge. Some agencies, he said, believe the scope of the standards is too broad because it covers organisms other than those modified by recombinant DNA techniques. He suggested that ABRAC members might consider meeting directly with the Secretary to express their views on the importance and timeliness of the standards. Dr. Sederoff voiced support for such an initiative.

Dr. Rissler, Union of Concerned Scientists, commended OAB and the ABRAC on the development of the performance standards. She said the current draft is an extraordinary document reflecting a level of scientific sophistication of which the Working Group and the ABRAC can be justly proud. She indicated, however, that there is still a gap in the Federal framework for regulatory coverage of fish and she asked if the performance standards could serve as a basis for a regulatory initiative in that area.

Ms. Cordle indicated that the interagency Joint Subcommittee on Aquaculture would be an appropriate forum to explore possible

implementation of the standards in a regulatory context. She also advocated the organization of Federal-State workshops to harmonize aquaculture research around the principles set out in the standards.

Dr. Pierce moved the following for ABRAC consideration:

> MOTION: The ABRAC endorses the *Performance Standards for Safely Conducting Research with Genetically Modified Fish and Shellfish*, and recommends that, after appropriate review of comments received and of suggestions made at the ABRAC meeting of November 17, 1994, these be finalized and forwarded for consideration to the Under Secretary of Agriculture for Research, Education, and Economics.

Dr. Marrone seconded the motion and, after a brief discussion, it passed by a margin of 13 in favor, 0 opposed, and 0 abstaining.

Dr. Lauderdale suggested that the aquatic Working Group standards could be a model for similar performance standards for other groups of genetically modified organisms and he advocated sharing them worldwide. Dr. Sederoff echoed the view of the performance standards as a model for other groups of organisms.

Dr. Letourneau asked if a document describing the development of the performance standards and emphasizing the broad base of participation could be written. Dr. Kapuscinski replied that her grant under the Sea Grant Program required her to write such a report about the workshop, and that she could write a paper for publication in a scientific journal which could also be an appendix to the standards.

Biotechnology Research Initiative

Dr. Young updated the ABRAC members on recent changes in the Federal science and technology policymaking structure. He also alerted them to an upcoming Federal report entitled *Biotechnology for the 21st Century: New Horizons* which will cover biotechnology research opportunities in agriculture, environment, manufacturing/ bioprocessing, and marine science/aquaculture research. He said OAB will share copies of the report with the ABRAC when it is published in the next few months.

Biotechnology Risk Assessment Research Program

Dr. Young reported that the annual solicitation for applications under the Biotechnology Risk Assessment Research Grants Program for FY 1995 had been published in the *Federal Register*. He noted that the ABRAC did not have an opportunity to have input on the FY 1995 program. The reason, he said, was that the time for ABRAC input

occurred between the expiration of the previous ABRAC charter and the renewal of the current charter. He affirmed, however, that ABRAC members should be able to apply for grants under that program because they had not participated in the FY 1995 process.

Dr. Kapuscinski questioned whether the ABRAC should have input on future risk assessment solicitations, especially if that participation places them in a conflict situation with respect to applying for grants under the program. Dr. Young pointed out that current legislation requires the risk assessment research program to consult with the ABRAC. Dr. Sederoff and Dr. Pierce suggested that if the ABRAC participation occurs early enough in the development of the solicitation, no conflict of interest should result.

Dr. Letourneau asked whether scientists involved in risk assessment research could present their results to the ABRAC. Dr. Young replied that the risk assessment research program has an annual researchers' conference, often in cooperation with EPA, and that an ABRAC meeting might be co-scheduled with one of those conferences.

Other Business

Dr. Young asked that the ABRAC address two organizational issues; selection of a vice chair and replacement of Dr. Harlander who recently resigned. Dr. Sederoff nominated Dr. Kapuscinski for vice chair. Dr. Kapuscinski thanked the Committee for the nomination and said she would like to think about it before accepting.

Dr. Young asked if Dr. Harlander should be replaced by a food scientist or by another kind of specialist. Various members and visitors suggested that Dr. Harlander's slot should be filled by another food scientist, a plant ecologist, a nutritionist, or an ecological population geneticist. After some discussion, the sense of the ABRAC was that a food scientist/nutritionist should be sought for the vacancy on the ABRAC left by Dr. Harlander's resignation.

Discussion of Possible New Working Group

Dr. Rissler, Union of Concerned Scientists, asked if the process of developing performance standards for aquatic research could be applied to other projects such as the ecological risks of transgenic plants. Drs. Reid and Letourneau and expressed support for this idea and Dr. Reid suggested the formation of an ABRAC working group on this subject.

Dr. Marrone expressed an interest in the ABRAC examining scientific issues associated with genetically engineered arthropods. Dr. Sederoff suggested that the ABRAC was well-positioned to develop performance standards for research with genetically modified arthropods as it had already done for fish and

shellfish. He requested that representatives of APHIS and other agencies be invited to the next ABRAC meeting to outline their thoughts on biotechnology including genetically modified arthropods.

Dr. Reid asked if the ABRAC could have any input on the biodiversity issue from which he felt a strong science presence was currently missing. Ms. Cordle said that some in USDA feel that ABRAC should focus strictly on scientific issues. Dr. Sederoff asked how biodiversity is related to agricultural biotechnology.

Dr. Rissler, Union of Concerned Scientists, suggested that the ABRAC address the ecological risks of large-scale plantings of transgenic crops. Dr. Letourneau supported that suggestion, noting that transgenic crops are being commercialized and that introgression of transgenes into wild populations may already be taking place.

Dr. Lauderdale noted that ecological assessment is an open topic. Dr. Fuchs argued that other organizations are doing environmental impact analyses and asked if the ABRAC was the proper forum for such an effort. Dr. Letourneau asked if APHIS is the proper group to determine what kind of research is performed. Dr. Kapuscinski added that APHIS has regulatory jurisdiction, but may not have the incentive or resources to address research questions.

Dr. Young said that OAB and ABRAC may have the capability to establish a new working group on ecological assessment of large-scale plantings of transgenic crops. Dr. Marrone contended that such an ABRAC activity may be a waste of time since APHIS is already doing environmental risk assessments. Dr. Young added that the working group could include an APHIS plant scientist.

Dr. Rissler suggested that an ABRAC working group in this area include outside experts such as Dr. Peter Kareiva or Dr. Hugh Wilson. Dr. Young suggested Dr. Jim Cook of ARS/CSREES because of his previous experience with the OECD working group on the large-scale release of transgenic crops.

Dr. Hill, ABRAC Chair, asked Dr. Letourneau to chair a working group on ecological assessment/arthropods to be composed of Drs. Marrone, Fuchs, Reid, Tiedje, and other experts as appropriate.

Dr. Thompson mentioned a National Science Foundation (NSF) committee on science and democracy on which he serves. Dr. Young invited Dr. Thompson to brief the ABRAC on the activities of the NSF committee at the next ABRAC meeting.

ABRAC members commended Ms. Maryln Cordle, upon her upcoming retirement, for all her work on behalf of the ABRAC over the past several years.

Dr. Hill adjourned the meeting at 5:50 p.m.

Approved:

SUSAN MCCULLOUGH
Rapporteur

DANIEL JONES
Editor

ALVIN YOUNG
Executive Secretary

WALTER HILL
Chair

APPENDIX A

LIST OF VISITORS

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL BIOTECHNOLOGY RESEARCH ADVISORY COMMITTEE

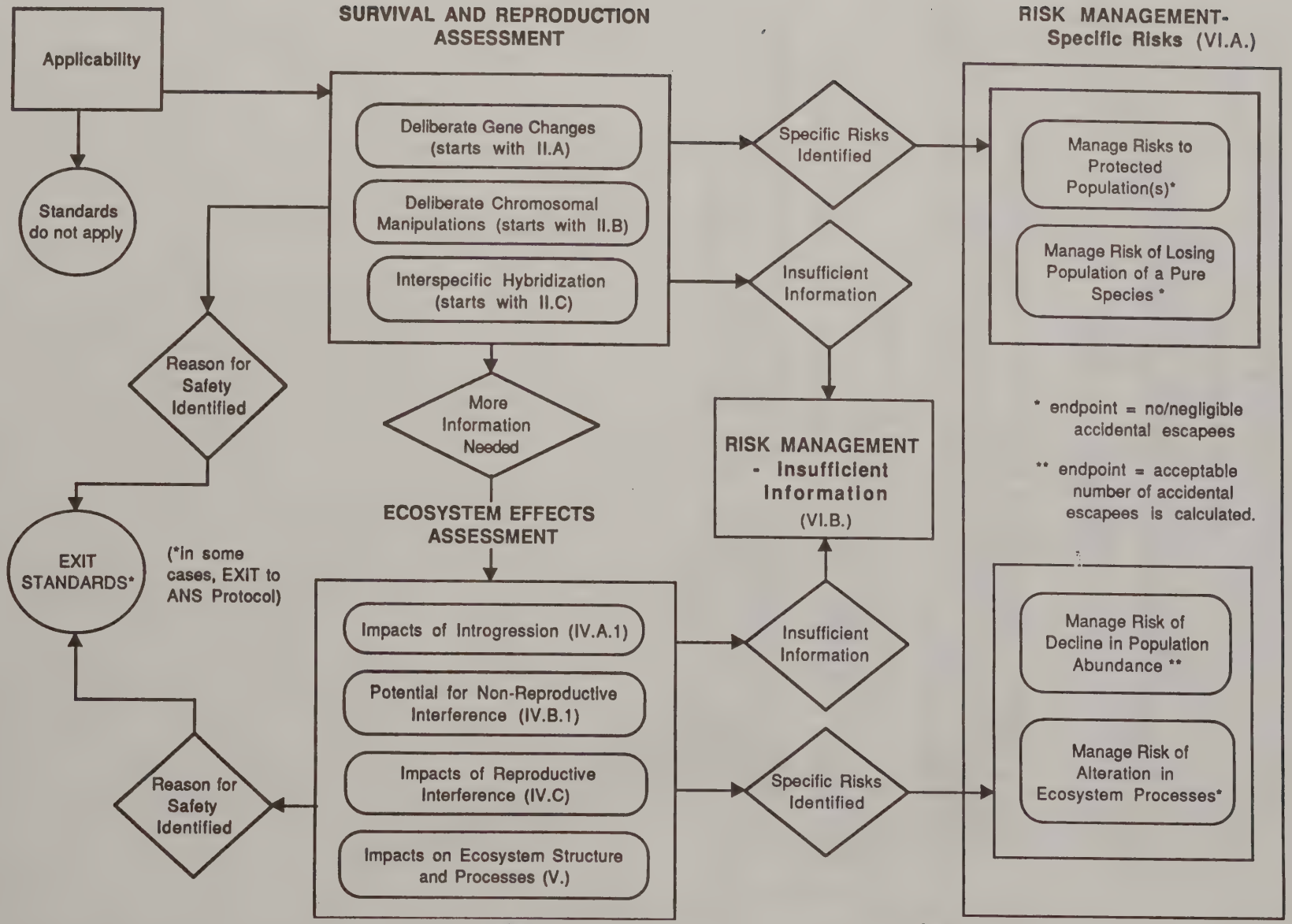
Monterey, California
November 17, 1994

Hubert Noteborn, Ministry of Agriculture, The Netherlands
Simon Barber, Agriculture Canada
Margriet Caswell, Economic Research Service, USDA
Ron Bloom, Center for Veterinary Medicine, U.S. Food and Drug Administration

Jane Rissler, Union of Concerned Scientists
Tom Zinnen, University of Wisconsin
Tom Edge, Environment Canada
Sue Tolin, Virginia Polytechnic Institute and State University

Gisele Kapuscinski, Monterey Institute of International Studies
John Colt, Montgomery Watson, Bellvue, WA
Peter Salm, Plant Sciences, Inc., Watsonville, CA
Norunn Myklebust, Directorate for Nature Management, Trondheim, Norway

OVERVIEW OF FLOWCHARTS DRAFT: 11/5/94

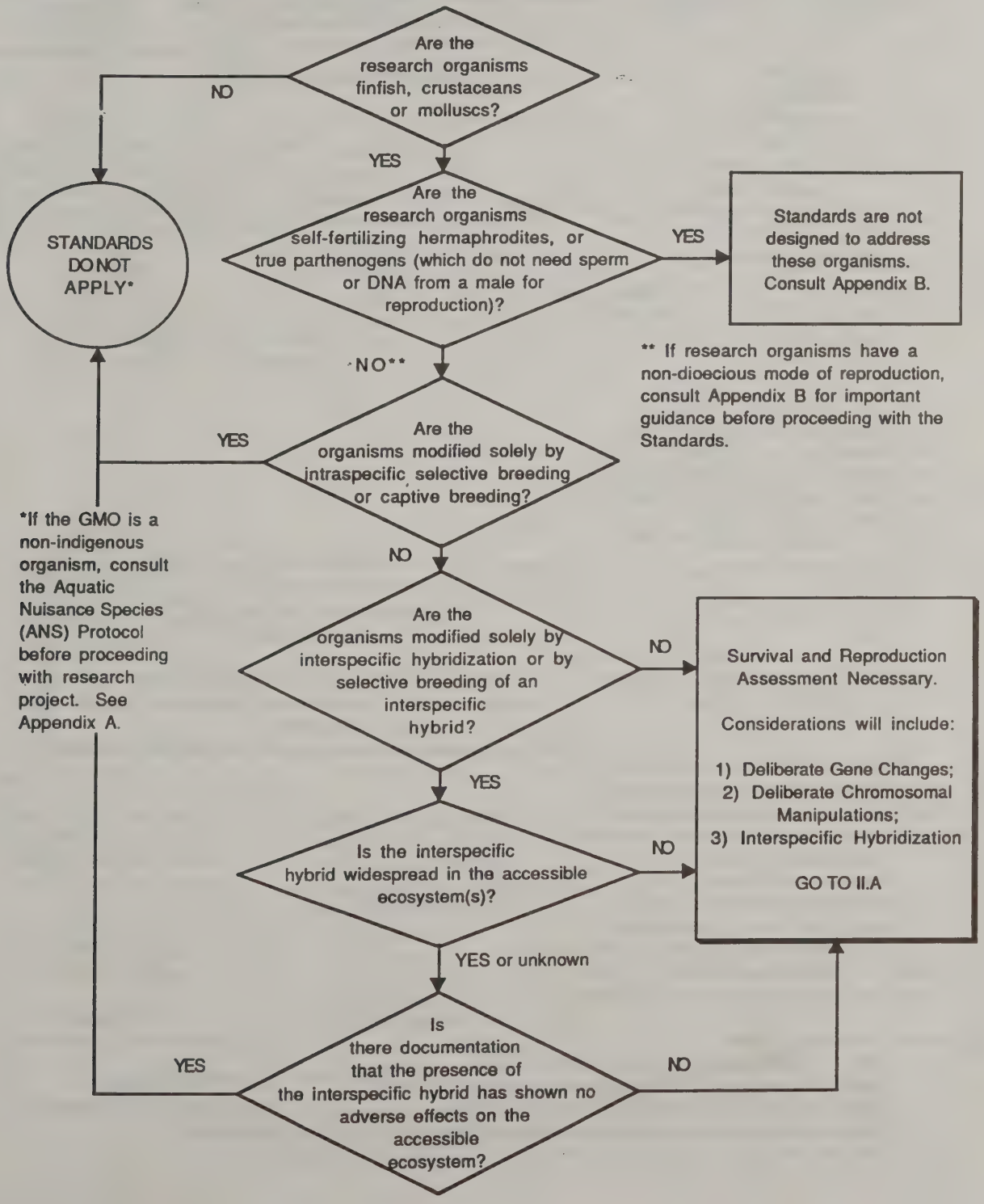


APPENDIX B

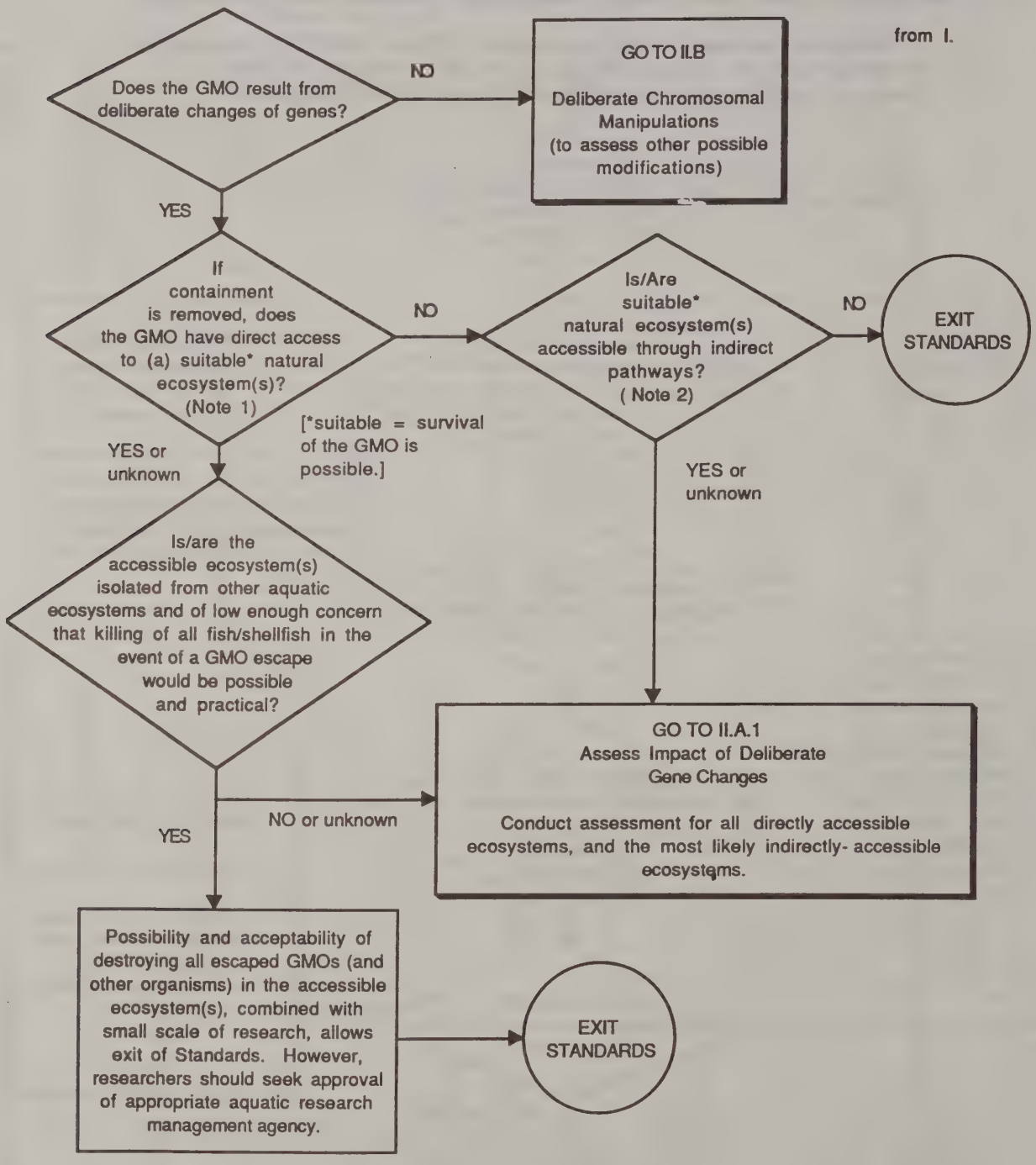
I. Applicability of Performance Standards for Research with Genetically Modified Finfish And Shellfish

DRAFT 11/5/94

The Standards are based on the precautionary principle. If answers to the questions in the Standards are unknown, the user is directed to proceed with further questions that will help the user determine appropriate risk management.



II.A Survival and Reproduction Assessment - Deliberate Gene Changes

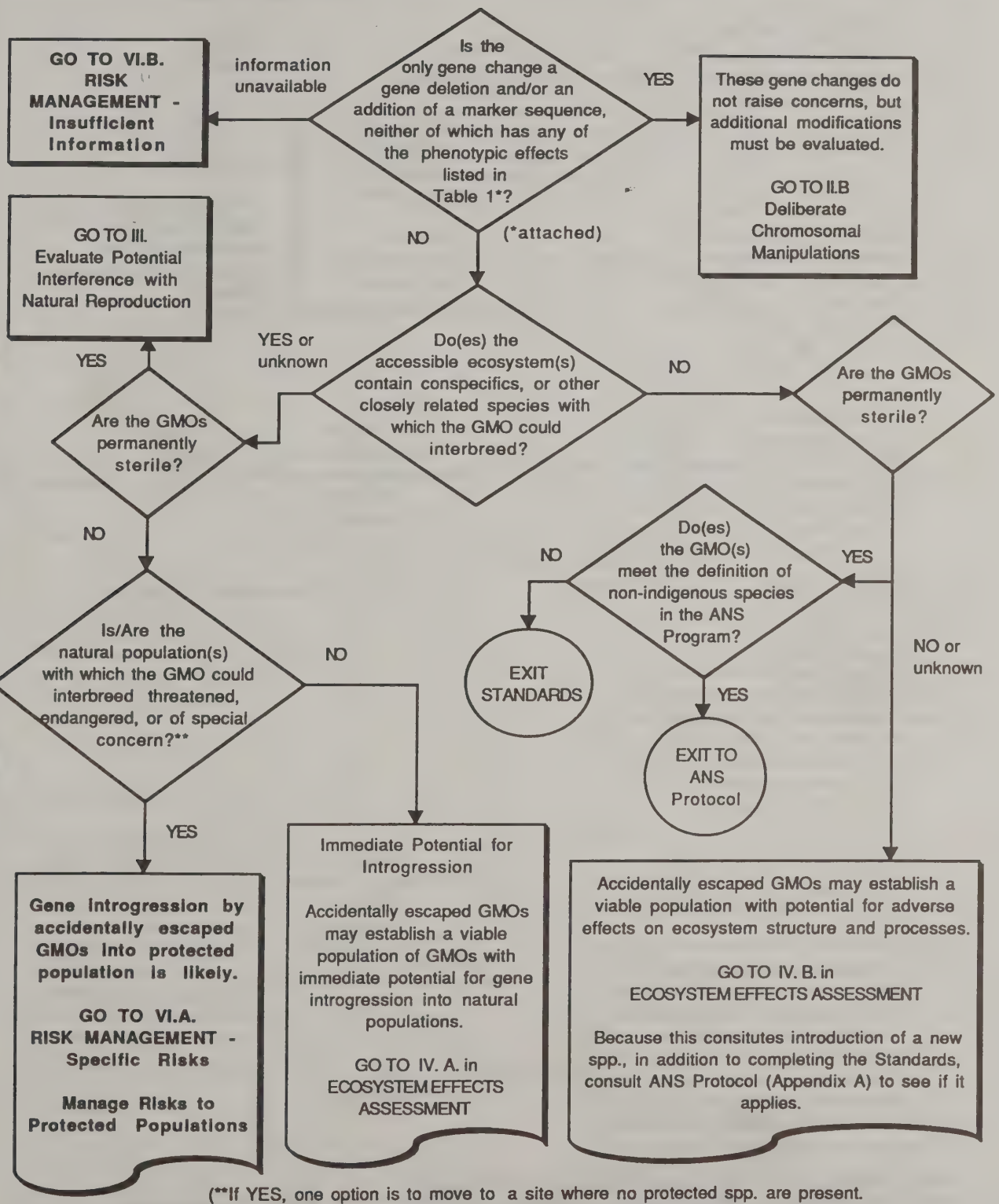


Note 1: Direct access is possible through natural waterbodies and human-created physical pathways, including navigation canals, and interbasin water transfers (e.g. irrigation, municipal water supply, etc.) See Appendix A: Table 2.

Note 2: See Appendix A: Table 2 for full list of such pathways.

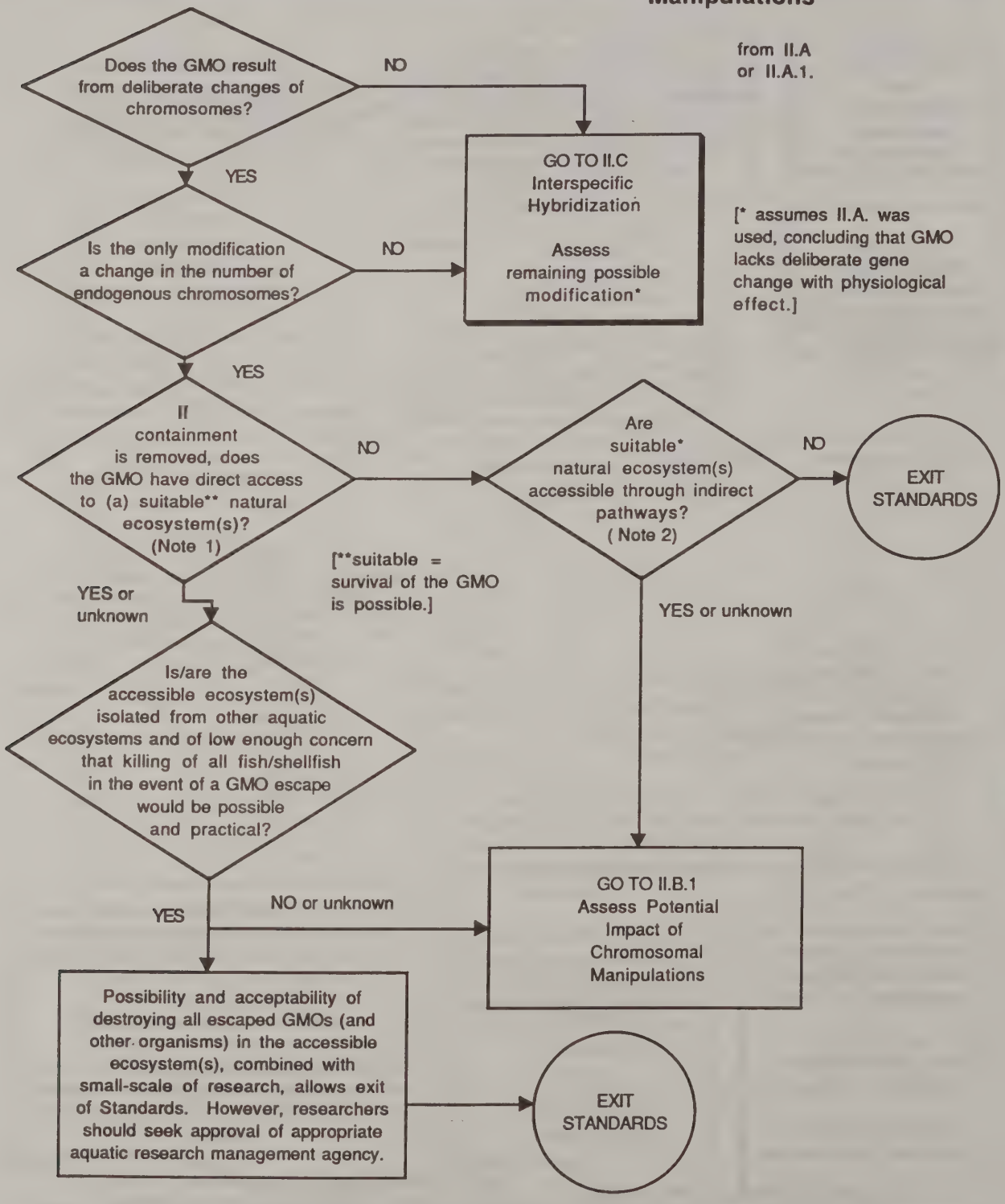
II.A.1 Impact of Deliberate Gene Changes

from II.A.



(**If YES, one option is to move to a site where no protected spp. are present. However, if this is considered, other topics in the Standards must be addressed. To explore the potential implications of site relocation, answer NO here and continue.)

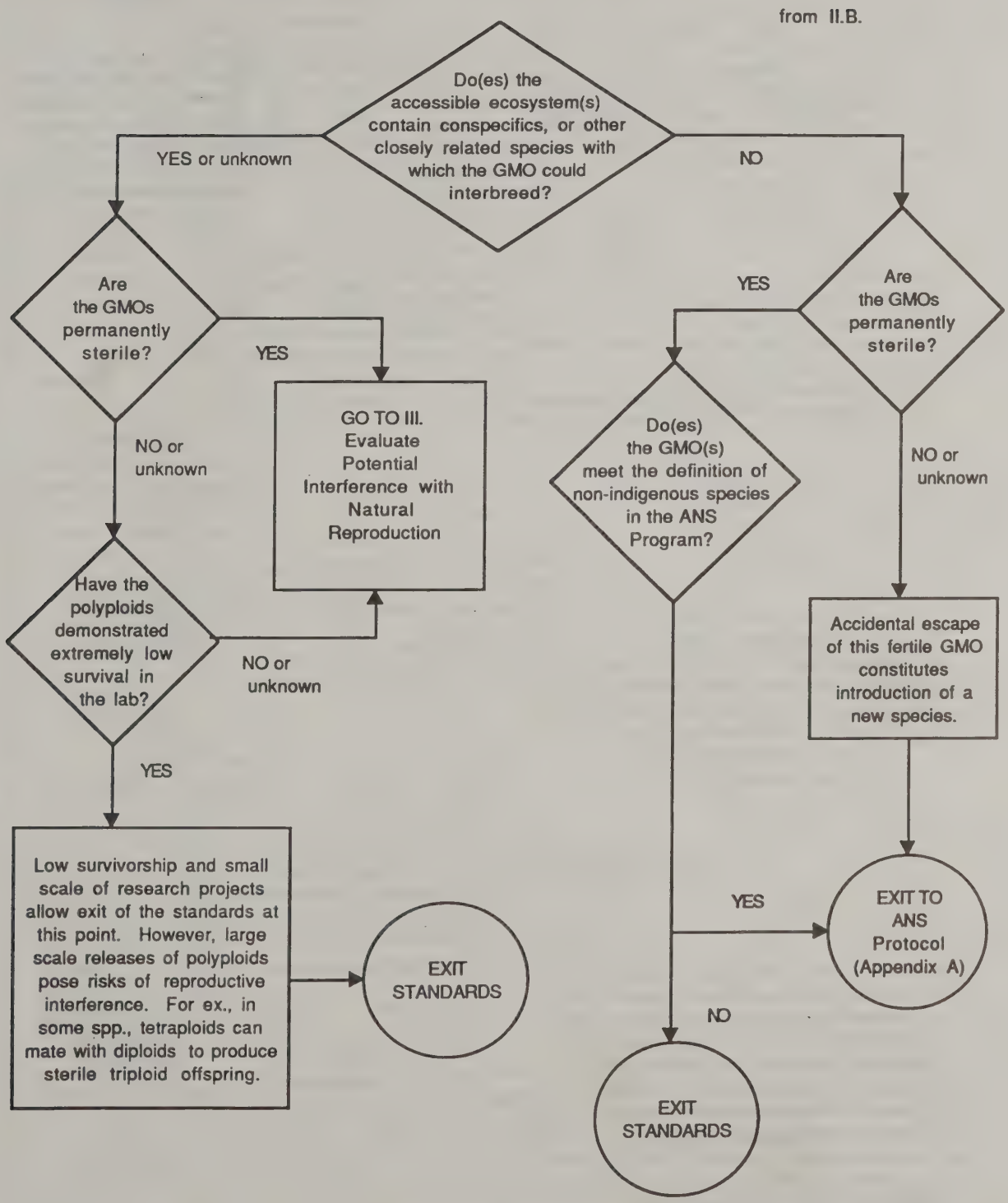
II.B. Survival and Reproduction Assessment - Deliberate Chromosomal Manipulations



Note 1: Direct access is possible through natural waterbodies and human-created physical pathways, including navigation canals, and interbasin water transfers (e.g. irrigation, municipal water supply, etc.) See Appendix A: Table 2.

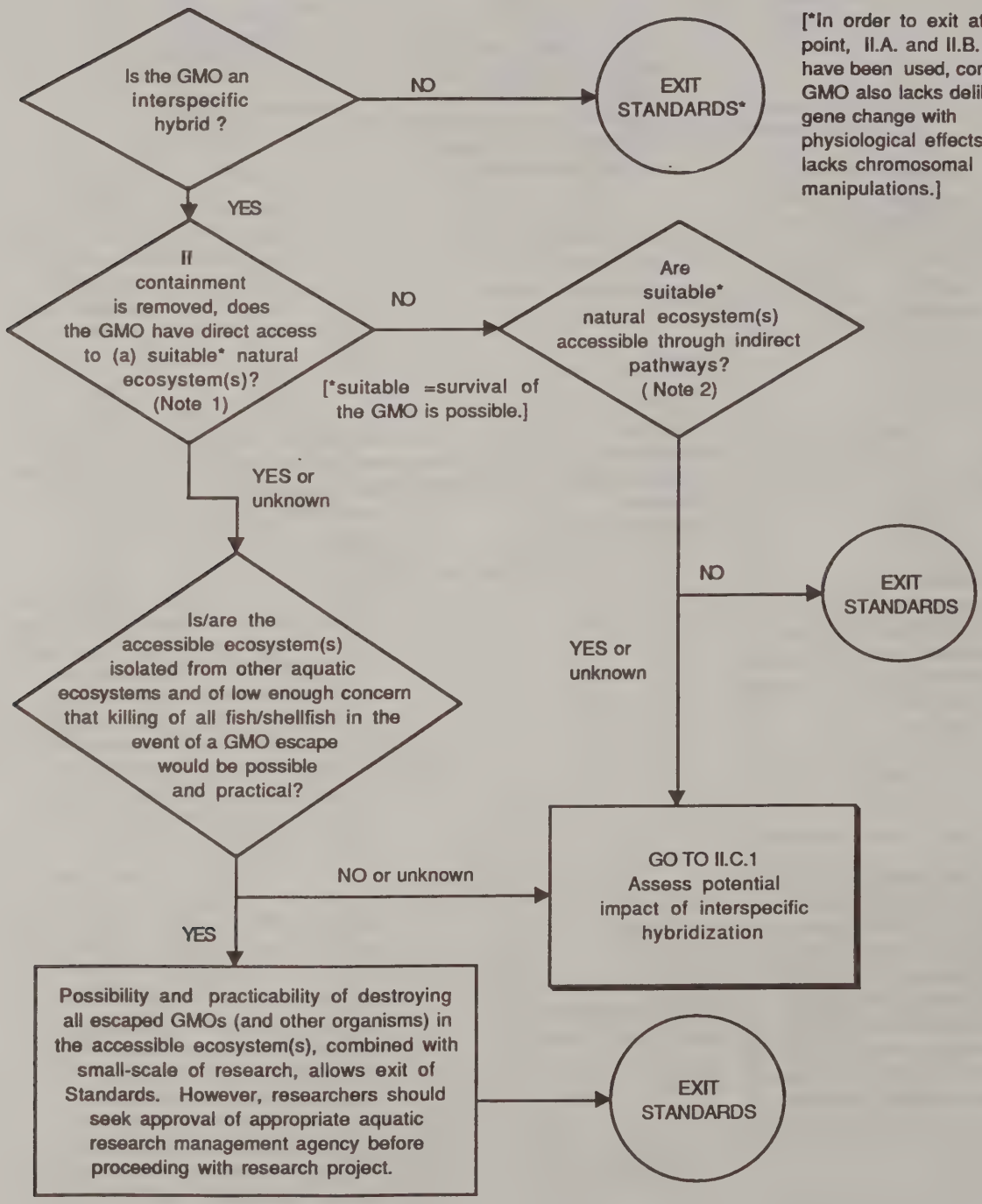
N ote 2: See Appendix A: Table 2 for full list of such pathways.

II.B.1 Impact of Deliberate Chromosomal Manipulations



II.C. Survival and Reproduction Assessment - Interspecific Hybridization

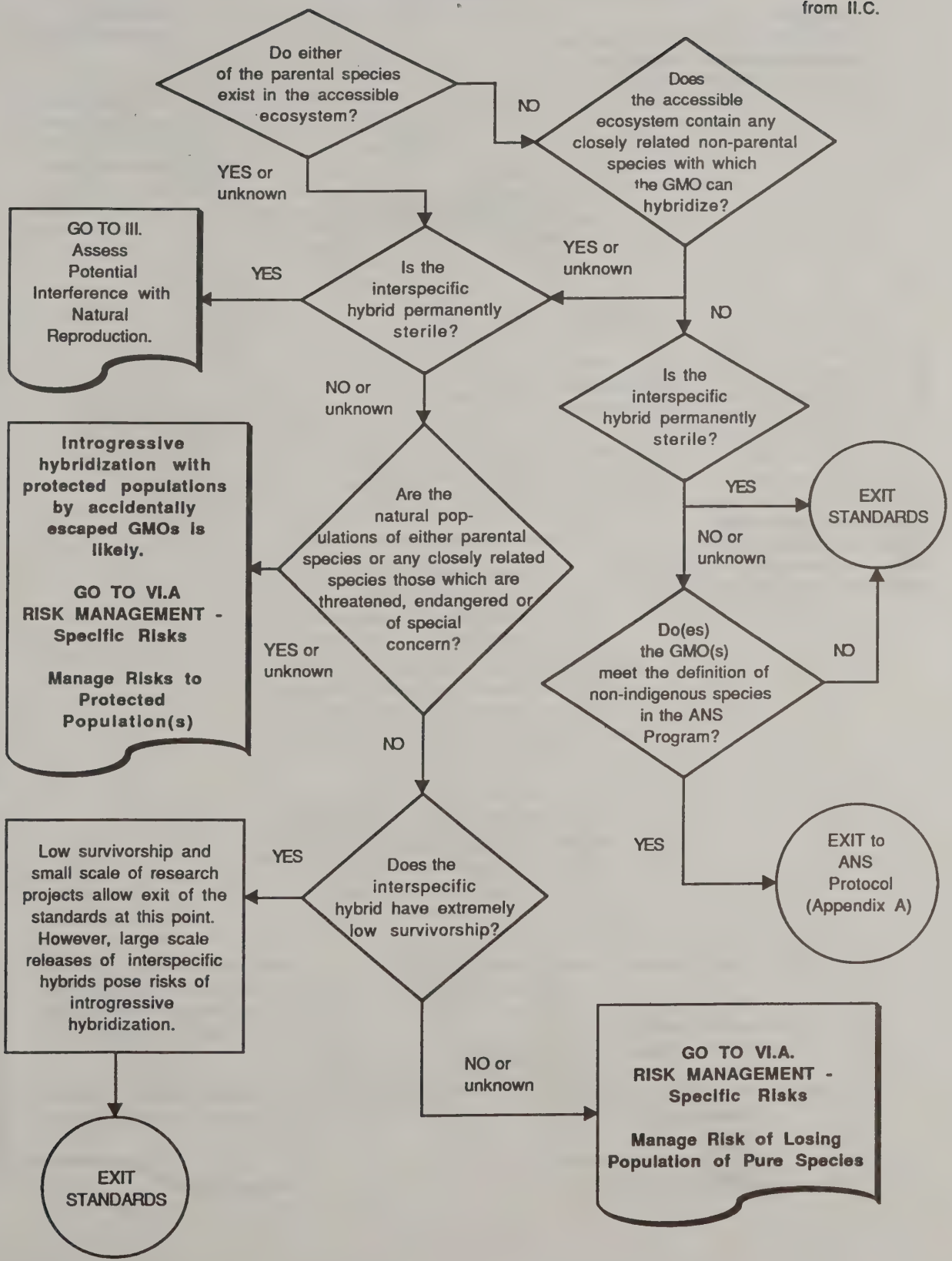
from II.B.



Note 1: Direct access is possible through natural waterbodies and human-created physical pathways, including navigation canals, and interbasin water transfers (e.g. irrigation, municipal water supply, etc.) See Appendix A: Table 2.

N ote 2: See Appendix A: Table 2 for full list of indirect pathways.

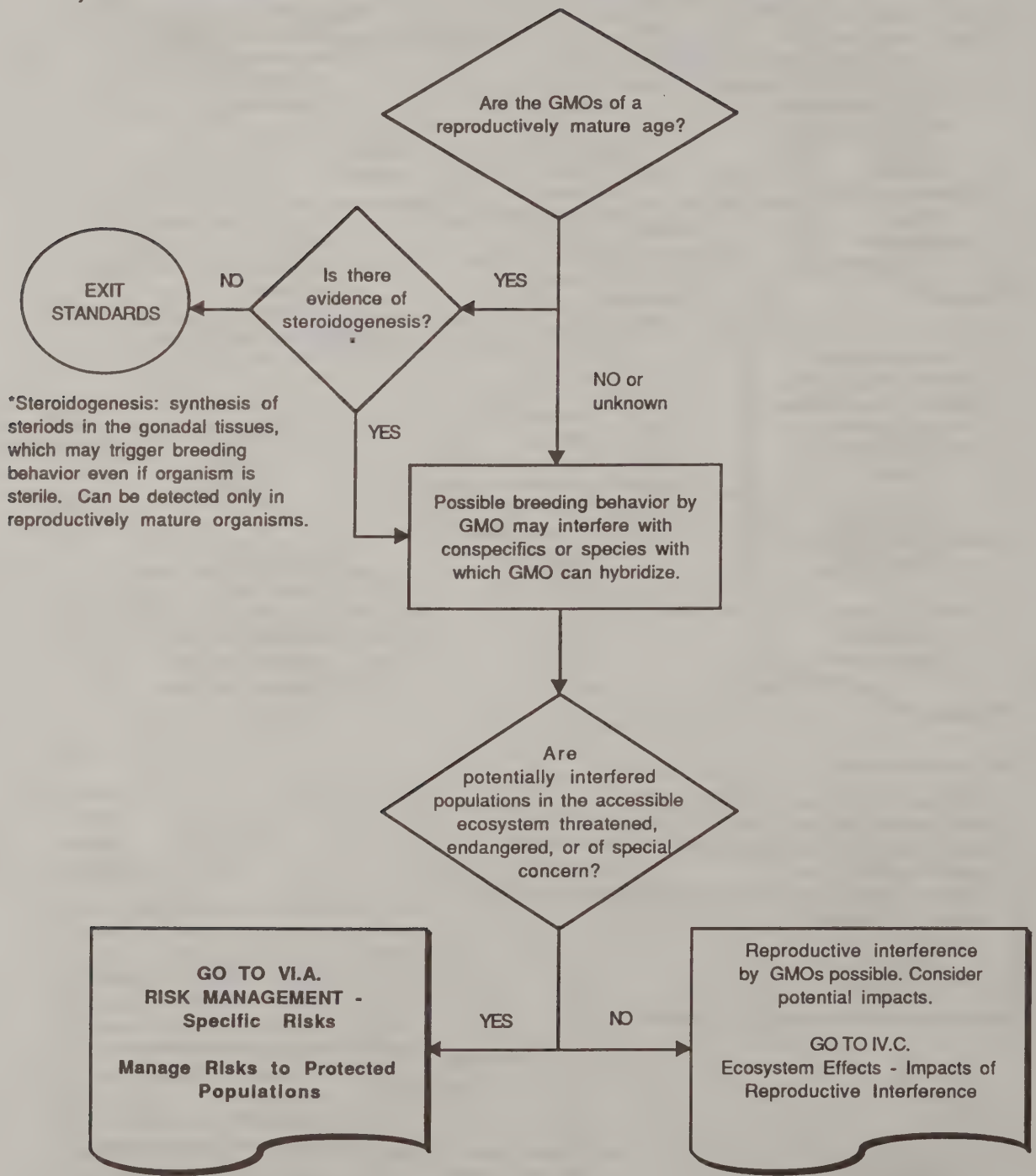
II.C.1 Impact of Interspecific Hybridization



III. Potential Interference with Natural Reproduction

from II.B.1
or II.C.1

These GMOs:
- ARE sterile or are fertile tetraploids
- have deliberate gene changes, or chromosomal changes, or are interspp. hybrids.



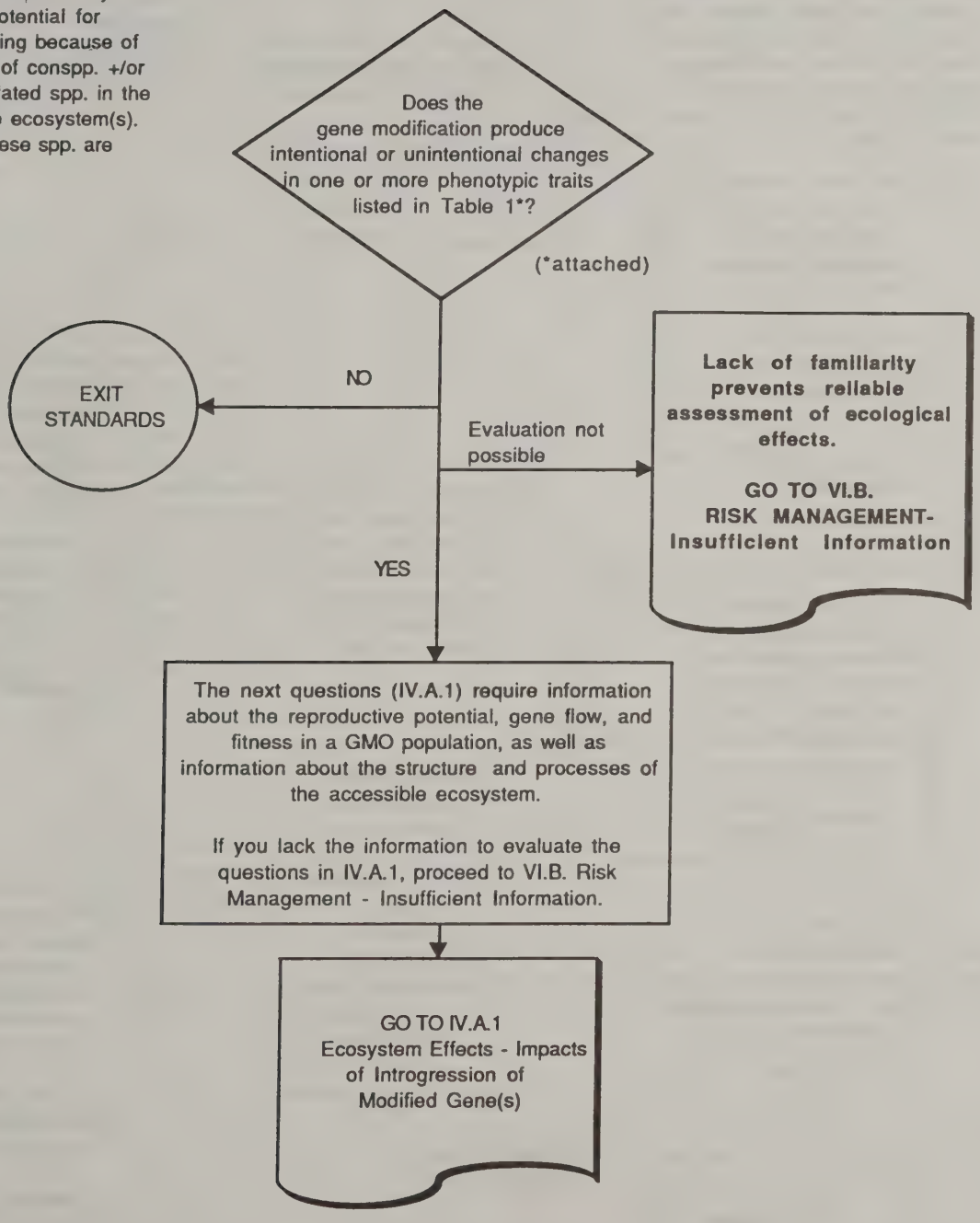
*Steroidogenesis: synthesis of steriods in the gonadal tissues, which may trigger breeding behavior even if organism is sterile. Can be detected only in reproductively mature organisms.

IV.A. Ecosystem Effects - Deliberate Gene Changes

These GMOs:

-are NOT permanently sterile
-do have potential for interbreeding because of presence of conspp. +/or closely related spp. in the accessible ecosystem(s). None of these spp. are protected.

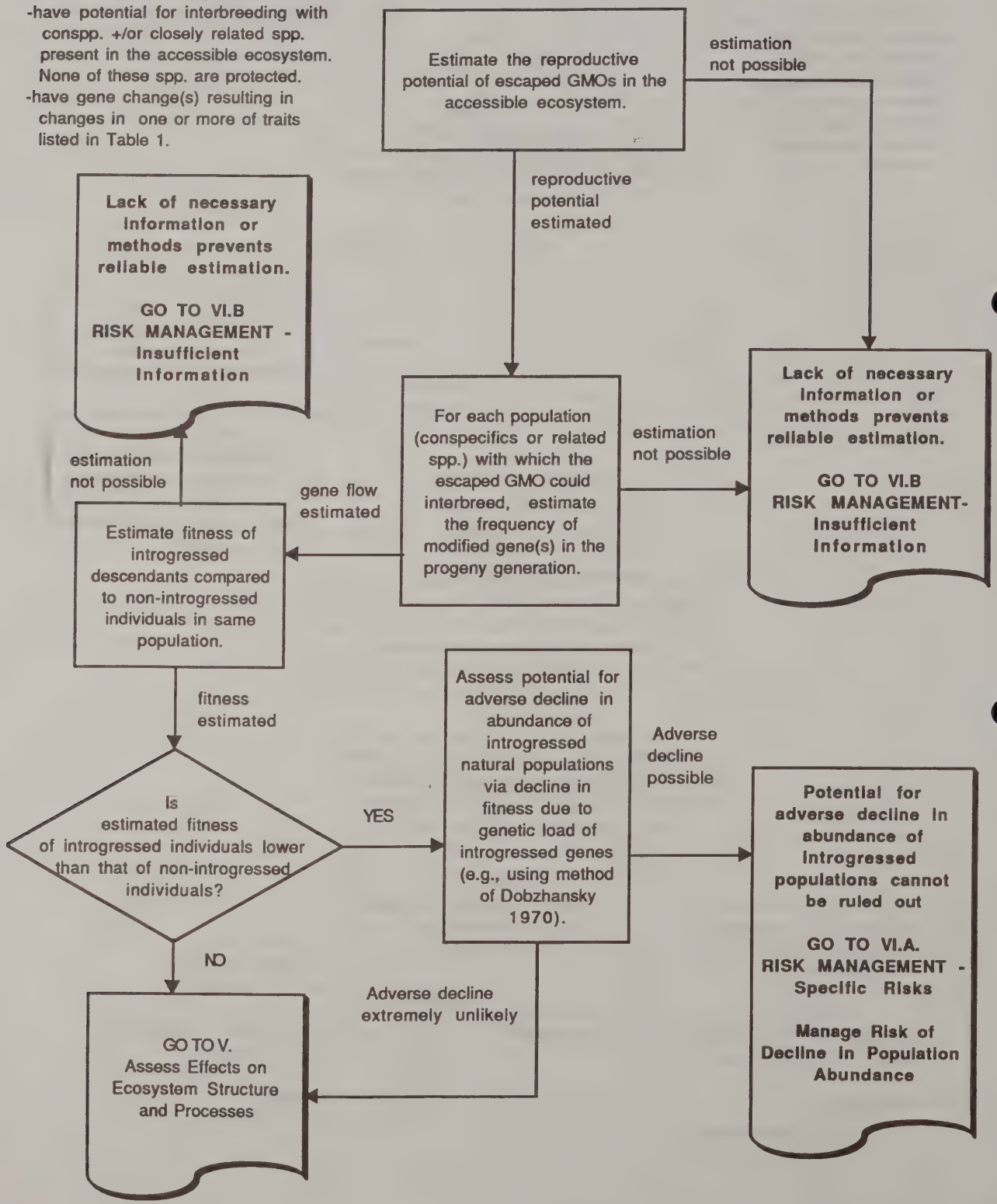
from II.A.1



IV.A.1 Ecosystem Effects - Impacts of Introgression of Modified Gene(s)

from IV.A.

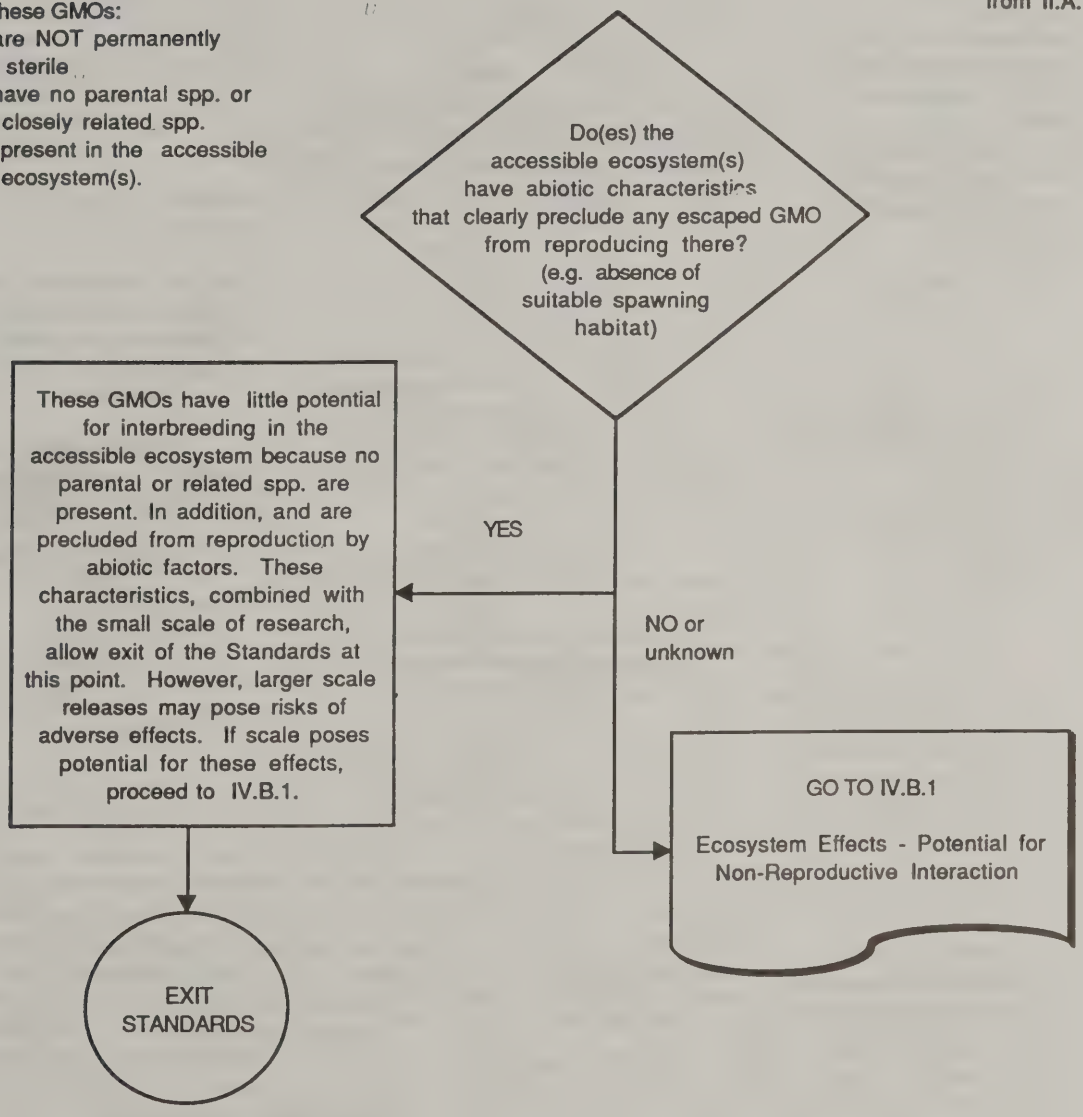
These GMOs:
-are NOT permanently sterile
-have potential for interbreeding with conspp. +/or closely related spp. present in the accessible ecosystem. None of these spp. are protected.
-have gene change(s) resulting in changes in one or more of traits listed in Table 1.



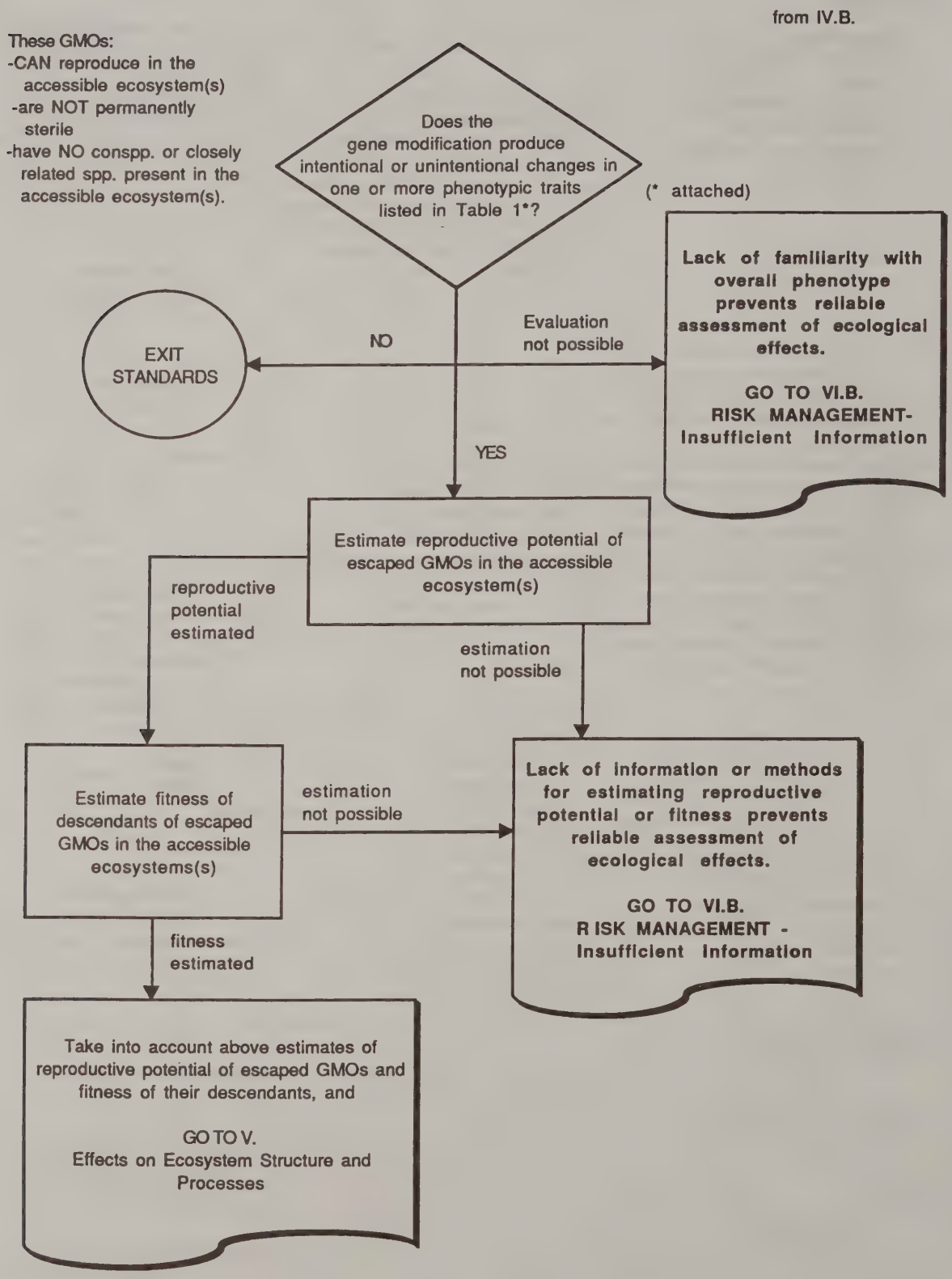
IV.B. Potential Barriers Associated with Accessible Ecosystem

from II.A.1.

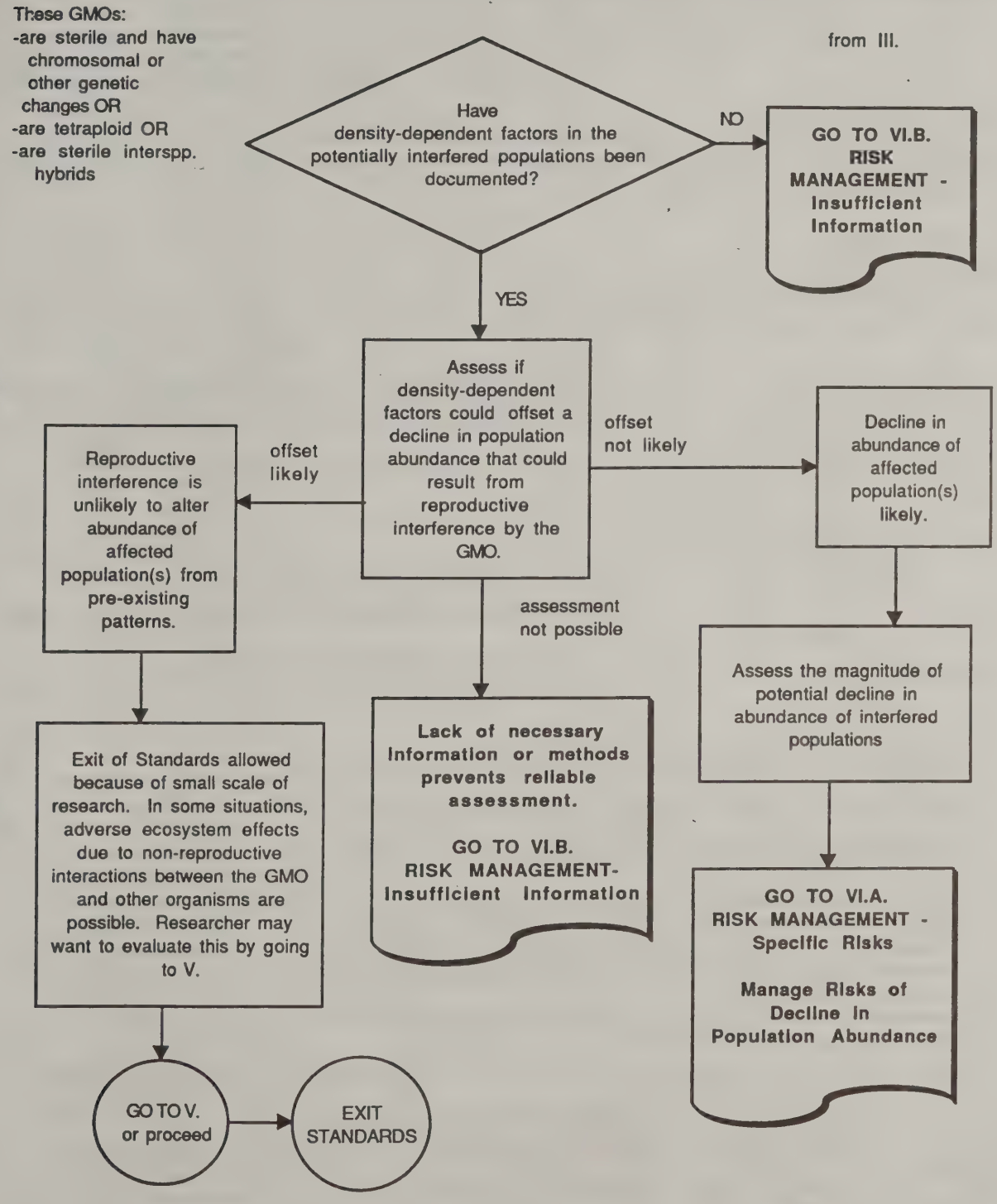
These GMOs:
-are NOT permanently sterile
-have no parental spp. or closely related spp. present in the accessible ecosystem(s).



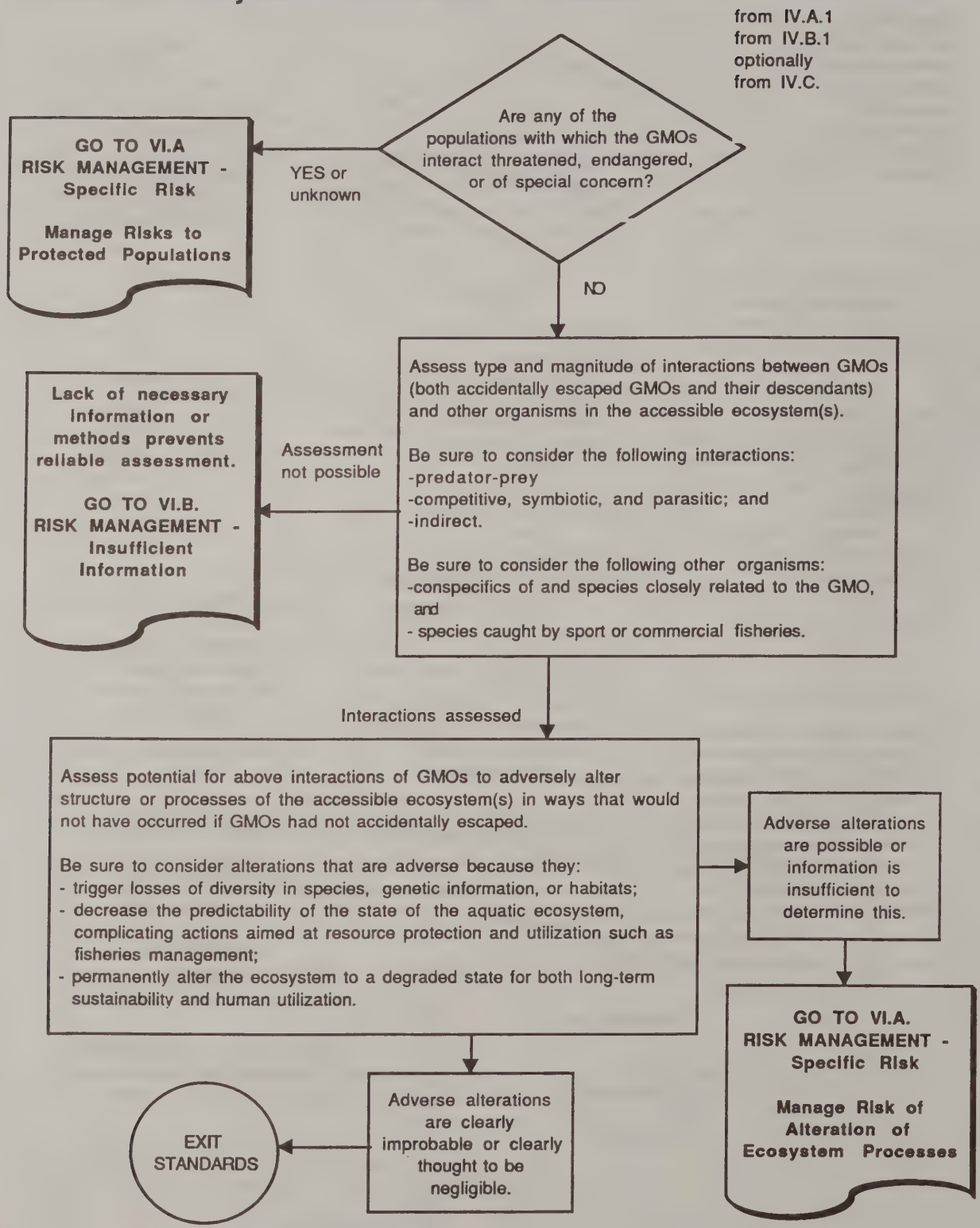
IV.B.1 Ecosystem Effects - Potential for Non-Reproductive Interaction



IV.C. Ecosystem Effects - Impacts of Reproductive Interference



V. Effects on Ecosystem Structure and Processes



VI.A. Risk Management - Specific Risks

Select from the list below the particular risk you have been instructed to manage. For each risk (or set of risks) the acceptable number of accidental escapees* is indicated in bold.

*Accidental escapees = combined outcome of scale of experiment and effectiveness of barriers.

Manage Risks to Protected Populations - from II.A.1or III.

no/negligible accidental escape.

Protected populations contain species which are threatened, endangered, or of special concern. Risks are gene flow, reproductive interference, or introgressive hybridization in these populations.

Manage Risk of Losing Population of Pure Species - from II.C.1

no/negligible accidental escape.

These GMOs are NOT sterile, and have parental/related spp. present, but none are protected spp. Concern is that populations of parental or related species will become introgressed by interspecific hybridization, so that they no longer constitute a distinct species, thereby posing the risk of losing an evolutionarily important component of the affected species' genetic diversity.

Manage Risk of Decline in Population Abundance - from IV.A.1 or IV.C.

acceptable number is one that ensures that accidental escapees are fewer than the number that will avoid a decline in the abundance of the affected population(s) resulting from lowered fitness or introgressed descendents (IV.A.1), or from reproductive interference (IV.C.)

From IV.A.I.: These GMOs are not sterile, and do have conspp. +/or closely related spp. present, but none are protected spp.

From IV.C.: T hese GMOs are sterile and have chromosomal or other genetic changes, or they are fertile/sterile tetraploids, or are sterile interspp. hybrids.

Manage Risk of Alteration of Ecosystem Processes - from V.

no/negligible accidental escape

These GMOs CAN reproduce in the accessible ecosystem(s), are NOT sterile, and have no conspp. or closely related spp. present. Risks of adverse alteration(s) in ecosystem processes exist.

Select sufficient barriers from the categories listed below to assure that accidental escapees are fewer than the acceptable number for your research project. Consult text of Risk Management Recommendations for details about project siting and design of barriers .

Ensure that your project meets requirements for security, alarms, operational plan and inspection, as explained in the text of the Risk Management Recommendation s.

PHYSICAL OR CHEMICAL BARRIERS
Barriers that induce 100% mortality in any life stage of the GMO before reaching an accessible ecosystem (water temperature, pH).

BIOLOGICAL BARRIERS OF GMO
Barriers that prevent any possibility of GMO reproduction or survival.

MECHANICAL BARRIERS
Barrier devices that physically hold back any life stage of the GMO from leaving the project site (e.g., screens).

SCALE OF EXPERIMENT
Maintain an experimental size small enough so that accidental escape of all organisms would not have an adverse ecological effects.

WRITTEN OPERATIONAL PLAN REQUIRE D
Develop and implement an appropriate written plan addressing all factors described in Operations subsection of Risk Management Recommendations.

→ STANDARDS ARE COMPLETED

VI.B. Risk Management - Insufficient Information

The precautionary approach of the Standards requires that in the absence of information to evaluate risk, the goal of risk management must be no/negligible accidental escape of GMOs.

*Accidental escapees = combined outcome of scale of experiment and effectiveness of barriers.

Insufficient Information at II.A.1.

no/negligible accidental escape

The phenotypic effect of the gene change(s) of these GMOs is unknown. Further risk assessment is not possible.

Insufficient Information at IV.A., IV.A.1.

no/negligible accidental escape.

These GMOs are NOT sterile . Conspp. or closely related spp. ARE present in the accessible ecosystem(s), but none are protected spp. Because the GMOs have an unfamiliar overall phenotype , unknown reproductive potential or unknown fitness, no determination can be made of their impact on the structure, function or resiliency of the accessible ecosystem(s).

Insufficient Information at IV.B.1.

no/negligible accidental escape.

These GMOs are NOT sterile, and have NO conspp. or closely related spp. present in the accessible ecosystem(s). No barriers to their reproduction in accessible ecosystem(s) are known to exist.
Because the GMOs have an unfamiliar overall phenotype , unknown reproductive potential or unknown fitness, no determination can be made of their impact on the structure, function or resiliency of the accessible ecosystem(s).

Insufficient Information at IV.C.

no/negligible accidental escape.

These GMOs are either sterile with chromosomal or other genetic changes, or are sterile intraspecific hybrids, or are tetraploid. Conspecifics or closely related species are present in the accessible ecosystem(s), but none are protected spp.

Information is insufficient to assess the effect of reproductive interference on the affected population(s), or to assess the combined outcome of density-dependent factors and reproductive interference .

Select sufficient barriers from the categories listed below to ensure no/negligible accidental escape of GMOs for your research project. Consult text of Risk Management Recommendations for details about project siting and barrier design.

Ensure that your project meets requirements for security, alarms, operational plan and inspection, as explained in the text of the Risk Management Recommendations .

PHYSICAL OR CHEMICAL BARRIERS
Barriers that induce 100% mortality in any life stage of the GMO before reaching an accessible ecosystem (water temperature, pH).

BIOLOGICAL BARRIERS OF GMO
Barriers that prevent any possibility of GMO reproduction or survival.

MECHANICAL BARRIERS
Barrier devices that physically hold back any life stage of the GMO from leaving the project site (e.g., screens).

SCALE OF EXPERIMENT
Maintain an experimental size small enough so that accidental escape of all organisms would not have an adverse ecological effects.

STANDARDS ARE COMPLETED

WRITTEN OPERATIONAL PLAN REQUIRE D
Develop and implement an appropriate written plan addressing all factors described in Operations subsection of Risk Management Recommendations.

Table 1. Classes and examples of possible phenotype changes in genetically modified fish, crustaceans, and molluscs.

Class	Examples of Phenotypic Change	Ecological Effect
Metabolism	- Growth rate - Enery metabolism - Food Utilization	Shift to different prey size - Alter nutrient and energy flows
Tolerance of Physical Factors	- Temperature - Salinity - pH - Pressure	- Shift preferred habitats - Alter geographic range
Behavior	- Reproduction - Territoriality - Migration - Chemosensory (including pheromones, allelochemicals) - Swimming/navigation	- Alter life history patterns - Alter population dynamics - Alter species interactions
Resource/Substrate Use	- Food utilization	- Release from ecological limits - Alter food webs
Population Regulating Factors	- Novel disease resistance - Reduced predation/parasitism - Habitat preference	- Alter population and communtiy dynamics - Release from ecological limits
Reproduction	- Mode - Age at maturation and duration - Fecundity - Sterility	- Alter population and community dynamics - Interfere with reproduction of related organisms
Morphology	- Shape and size - Color - Fin/appendage form	- Alter species interactions
Life History	- Embryonic and larval development - Metamorphosis - Life span	- Alter life history patterns - Alter population and community dynamics